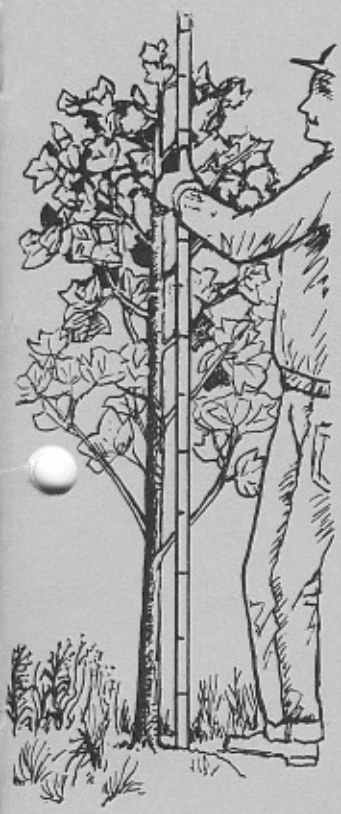

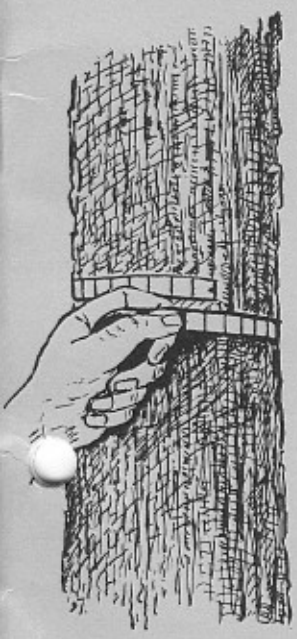

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DIRECT SEEDING BLACK WALNUT

Virginia Division of Forestry
Department of Conservation and Economic Development

RESULTS FROM A BLACK WALNUT DIRECT SEEDING STUDY

by

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ABSTRACT

A black walnut direct seeding study was installed on four widely separated tracts. Nine nuts were sown per spot, using non-stratified nuts in November and stratified nuts in March. Half of the spots were protected from squirrels with screen wire. One year old walnut seedlings were planted in March. In a supplemental study, small, medium and large walnuts were sown in depths of 3, 5 and 7 inches.

March sowing was more successful than November. Medium size nuts produced the most seedlings, with large nuts a close second and small nuts a distant third. The 3 inch sowing depth produced more seedlings than the 5 and 7 inch sowing depths. Squirrels were not a problem on any of the four tracts and protecting spots did not increase stocking. After seven years, direct seeded seedlings were almost as tall as planted seedlings and were growing at the same rate.

INTRODUCTION

On cut-over woodland sites, pilfering of walnuts by squirrels may preclude use of direct seeding. Some preliminary tests on abandoned fields and pastures, however, suggested that direct seeding of black walnuts on non-forested sites might be feasible. Direct seeding of black walnut would be cheaper than planting. During the fall and spring of 1975-76, we installed a study to test direct seeding of black walnut on abandoned fields and pastures. The main study involved a comparison of fall and spring direct seeding with spring planting, and was installed on four different tracts widely scattered over the western part of the State. A smaller, supplemental study of the effect of seed size and depth of sowing was installed adjacent to the main study on three of the four tracts.

1/ Chief, Applied Forest Research and Reforestation, and State Forester

PROCEDURE

Main Study

Nine walnuts were sown in each spot, placing the walnuts at the same depth, side by side and as close together as possible to keep the spot small. The nuts were covered with about an inch of soil. Non-stratified nuts were sown in November and stratified nuts in March. Rows of 20 spots each were installed at a spacing of 6.6 feet between spots and rows. Every other spot was protected from squirrel pilferage with a square piece of half-inch mesh screen wire stapled down at the corners. A 20 seedling row of one-year-old black walnut seedlings was planted in March at the same spacing. There were, therefore, three treatments: seeded in November, seeded in March, and planted in March; replicated three times in randomized blocks, so that the entire study on each tract contained 60 spots seeded on each date and 60 planted seedlings. A mixture of Simazine and Paraquat was sprayed around each spot and each planted seedling immediately after planting, being careful not to apply herbicide directly over the nuts. Herbicide treatment was continued for three years, applying the herbicide early in the spring before the walnuts leafed-out.

At the end of the first growing season, all seedlings were counted and the tallest four seedlings in each spot (if there were as many as four seedlings) were measured for total height. A loop of plastic flagging was placed at the groundline around each of the four tallest seedlings so they could be identified in subsequent measurements: tallest-blue, second tallest-yellow, third tallest-orange, and fourth tallest-red. The protective wire screens were removed at the end of the first growing season, after the leaves had fallen off. None of the walnut seedlings had side branches at the end of the first season, and the wire screens could be removed easily without damage to the seedlings.

No seedlings were removed from any of the spots during the seven years following establishment of the study. Corrective pruning was done as needed on the more promising seedlings in each spot, but no seedlings were cut back in height. After the 7 year measurement we thinned each spot to the most promising seedling, which in most cases was also the tallest seedling.

Supplemental Study

Holes of 1 inch, 1-1/4 inch, and 1-1/2 inch diameter were used to size black walnuts into small, medium and large classes. Large nuts were greater than 1-1/2 inches, medium from 1-1/4 to 1-1/2 inches, and small from 1 to 1-1/4 inches in greatest diameter. Nuts smaller than 1 inch in diameter were discarded. We had to size about 1,600 nuts in order to get 200 large and 200 small walnuts. Stratified nuts were used, and they were sown in March.

The three sizes of walnuts were sown at three different depths, in holes 3 inches, 5 inches, or 7 inches deep. There were, thus, nine treatment combinations, three nut sizes x three sowing depths. The nine treatments were replicated four times in randomized blocks, sowing a row of eight nuts for each treatment in each replication, for a total of 32 nuts in each treatment. Spacing was 1 foot x 1 foot. The entire study was covered with chicken wire to prevent losses to squirrels, and the wire was removed at the end of the first season. Weeds and grass were controlled with herbicides for three years, as in the main study.

Corrective pruning was done as needed on the more promising seedlings, but seedlings were not cut back in height. The final measurement was made after five growing seasons, because the seedlings were becoming very crowded, and after the five year measurement we thinned the plots.

Planting Sites

We tried to select areas that would be good black walnut sites. Three of the planting sites were on first bottom, or flood plain, positions and the fourth was on a second bottom, or first terrace, position. Top soil texture ranged from sandy loam to silt loam. One planting site was in the Central Piedmont, one in the foothills of the Blue Ridge, one in the northern Shenandoah Valley, and one in the Valley and Ridge area of southwest Virginia.

RESULTS FOR MAIN STUDY

Stocking

Stocking in the direct seeded spots was better for March seeding than for November seeding, as shown in Table 1. The percent of spots with at least one seedling at the end of the first season averaged 76 percent for November seeding and 90 percent for March seeding, and the average number of seedlings per spot averaged 1.9 for November seeding and 2.6 for March seeding. Survival of planted seedlings was excellent, averaging 98 percent over the four tracts.

Table 1. First season stocking and survival.

Tract	Percent of Spots Stocked and Average Number per Spot: November %	November Number	March %	March Number	Planting Survival
Bowman	95	2.5	93	2.8	100
Currin	75	1.7	95	2.5	98
Smith	73	1.4	85	2.8	95
White Hall	63	1.9	87	2.4	98
Means	76	1.9	90	2.6	98

Pilferage by squirrels was not a problem on any of the four tracts. Protecting seeded spots with screen wire did not improve stocking, as shown in Table 2.

Table 2. First season stocking of protected and unprotected spots

Tract	Average Number per Spot: November Protected	November Not	March Protected	March Not
Bowman	2.6	2.4	2.6	3.0
Currin	1.6	1.8	2.3	2.7
Smith	1.2	1.7	2.9	2.8
White Hall	2.1	1.6	2.3	2.4
Means	1.9	1.9	2.5	2.7

Not many spots had more than four seedlings at the end of the first growing season, as shown in Table 3. With the exception of two spots that each had 8 seedlings, all other spots had 6 seedlings or less.

Table 3. Percent of spots by number of seedlings per spot, at the end of the first growing season, on all four tracts combined.

Number Per Spot	Percent of Spots	
	November	March
0	23	14
1	26	13
2	18	22
3	16	19
4	9	20
5	5	7
6	2	5
7	0	0
8	.4	.4
Totals	99.4	100.4

Over the six year period between the end of the first and the end of seventh growing season, when the final measurement was made, about 14 percent of the direct seeded seedlings died. Mortality does not seem to have been related to the initial number of seedlings in each spot, as shown in Table 4. This suggests that seedlings did not die because of over-crowding through age 7.

Table 4. Percent mortality between the first and seventh seasons, by number of seedlings per spot after the first season

Number Per Spot	Percent Mortality		
	November	March	Means
1	13	19	16
2	14	8	11
3	16	12	14
4	16	10	13
Means	15	12	14

Height Growth

Planted seedlings did not grow much in height the first two years. In fact, on two of the four tracts top dieback resulted in average height being less after two seasons than when the seedlings were planted. Height growth of planted seedlings picked up considerably during the third season and reached a maximum during the fourth season. If we consider just the tallest seedling in each direct seeded spot, direct seeded seedlings grew faster

than planted seedlings for the first three years, and after the third season direct seeded and planted seedlings grew at about the same rate, as shown in Figure 1. Average height of planted and direct seeded seedlings after 7 seasons in the field is shown for each tract in Table 5. The planted seedlings after 7 seasons in the field are actually eight years old.

Table 5. Average height in feet of planted seedlings and tallest seedling in each seeded spot, after 7 seasons.

	Tract				
Treatment	Bowman	Currin	Smith	Whitehall	Means
Planted	13.0	9.1	8.8	9.3	10.0
November Seeded	11.6	9.1	8.3	8.6	9.4
March Seeded	12.2	8.0	8.7	9.0	9.5
Means	12.3	8.7	8.6	9.0	

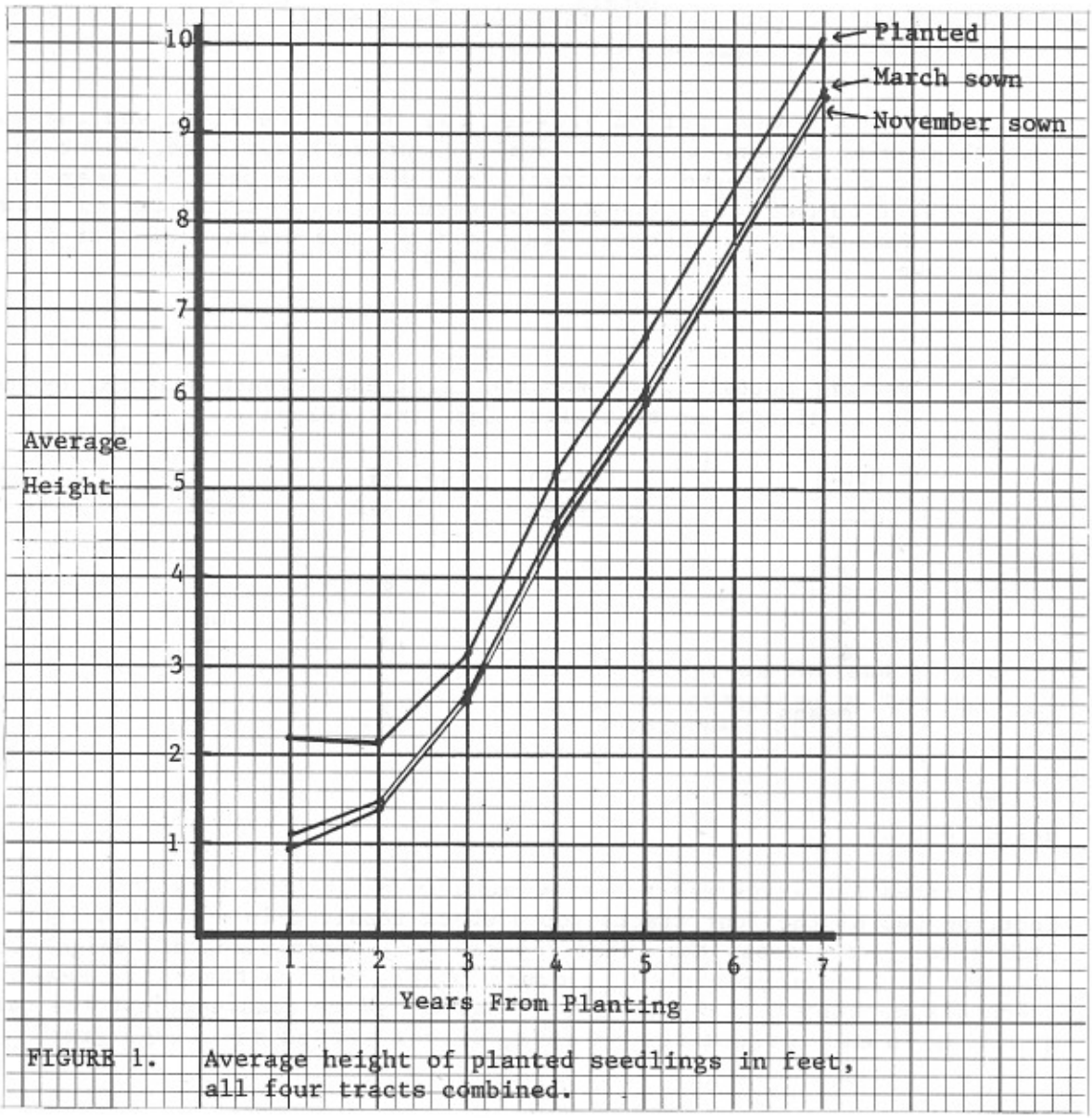

FIGURE 1. Average height of planted seedlings in feet, all four tracts combined.

No seedlings were cut in any of the spots through the 7 years that the study was measured. We initially thought that competition for growing space might suppress height growth in spots with several seedlings. Each year we plotted the height of the tallest seedling over the number of seedlings in each spot to see if height growth was being suppressed. There was no consistent tendency toward suppression in these plottings through age 7. In spots with several seedlings, the shorter seedlings were frequently suppressed, but the tallest seedling generally was not. On two of the four tracts, average height of the tallest seedling tended to increase slightly with increasing number of seedlings per spot, and on the other two tracts average height tended to decrease slightly.[1/] Walnut seedlings vary in height growth capacity, and any tendency for competition to reduce height growth may have been offset by the probability that one of several seedlings in a spot would be a faster than average grower.

Consequently, we delayed doing any thinning until after the 7th season. One obvious advantage of delaying thinning is that it gave us more opportunity to select for the best quality seedling in each spot, which allowed us to select better crop trees and minimized the amount of corrective pruning needed. Also, the seedling that was tallest after the first season was not always the tallest after 7 seasons. While it is true that for the majority of spots the seedling that was tallest initially was still tallest after 7 years, there was enough change in ranking to make it worthwhile to wait, as shown in Table 6. Averaging all four tracts (the last column in Table 6), only 46 percent of the seedlings that were tallest at age 1 were still tallest at age 7, and 6 percent of the seedlings that were fourth tallest at age 1 had outgrown their three taller neighbors to become tallest at age 7.

[1/] Simple linear regressions were fitted to the 7 year data for each tract separately. These regressions were not statistically significant for the Bowman and Smith tracts, but were significant for the Currin (positive slope) and White Hall (negative slope) tracts:

Tract	a	b	r^2	Probability of a larger F
Bowman	11.27	.227	.011	.273
Currin	6.33	.873	.054	.023
Smith	8.92	-.166	.007	.430
White Hall	10.25	-.488	.066	.023

When these separate regressions were tested for common slopes, the slopes were significantly different (Probability of larger F = .002).

Table 6. The tallest seedlings (in each spot with four or more seedlings) at age 7 related to height ranking at age 1.

Height Ranking at age 1	Tallest seedling in each spot at age 7				
	Bowman	Currin	Smith	White Hall	Means
			percent		
Tallest	49	50	32	54	46
Second	23	35	26	43	32
Third	17	10	32	4	16
Fourth	11	5	10	0	6
	100	100	100	100	100

Variation in Site Quality

Considerable variation in site quality showed up in all replications, on all four planting sites. On three of the four planting sites, we ran treatment rows perpendicular to the river, across the flood plain or terrace. On the fourth planting site, the plots were located in a bend of the river, and one replication was perpendicular and two were more or less parallel to the river. In most cases, the variation in site quality tended to occur perpendicular to the treatment rows. Because replications were only three rows wide (about 20 feet wide) the variation in site quality tended to be about the same on all three rows of a replication, so that treatment means were not biased.

It is interesting, though, that so much variation occurred in rows only 132 feet long (20 spots 6.6 feet apart). The variation is illustrated in Table 10, using heights of planted seedlings at age 7.

Table 7. Height variation among planted seedlings at age 7.

Tract	Rep.	Height in Feet			Standard Deviation	Coefficient of Variation
		Shortest	Average	Tallest		
Bowman	1	7.1	13.7	17.0	2.8	20
	2	7.5	12.7	17.0	2.5	20
	3	8.8	12.7	15.9	1.8	14
Currin	1	2.6	9.4	22.2	6.4	68
	2	3.1	8.8	20.0	5.9	67
	3	3.2	9.2	19.1	4.9	53
Smith	1	5.1	8.7	17.2	3.1	36
	2	7.6	10.1	14.9	2.4	24
	3	2.6	7.5	13.3	3.6	48
White Hall	1	6.2	11.2	15.8	3.2	28
	2	5.9	9.1	13.4	2.0	22
	3	1.3	7.6	11.4	2.2	29

RESULTS FOR SUPPLEMENTAL STUDY

Stocking

Stocking at the end of the first season was related to both nut size and sowing depth, as shown in Table 8. Medium-sized nuts produced the most seedlings on all three tracts. Large nuts produced almost as many seedlings as medium nuts, but small nuts produced considerably fewer seedlings on all three tracts.

The 3 inch sowing depth produced the most seedlings on all three tracts. The 5 and 7 inch depths were almost as good on the Smith tract, but on the Bowman and Currin tracts stocking decreased considerably with increasing depth of sowing.

Table 8. Number of seedlings at the end of the first season as a percent of the number of nuts sown.[1/]

Tract	Nut Size	Sowing Depth 3 inch	5 inch	7 inch	Means
Bowman	small	28	19	12	20
	medium	59	31	22	37
	large	47	28	19	31
	Means	45	26	18	30
Currin	small	22	9	6	12
	medium	31	25	16	24
	large	34	16	9	20
	Means	29	17	10	19
Smith	small	12	3	6	7
	medium	38	28	31	32
	large	25	31	31	29
	Means	25	21	23	23

Height Growth

After five growing seasons, there were not any strong and consistent relationships between height and either nut size or sowing depth, as shown in Table 9. The small nuts tended to produce smaller seedlings than the medium and large nuts, and the 3 inch sowing depth tended to produce somewhat larger seedlings than the 5 and 7 inch sowing depths.

1/ Separate analyses of variances were made for each tract:

Tract	Probability of Larger F Value: Size	Depth	Size x Depth
Bowman	.089	.006	.814
Currin	.253	.033	.944
Smith	.0002	.750	.732

Table 9. Average height in feet after five seasons[1/]

Tract	Nut Size	Sowing Depth 3 inch	5 inch	7 inch	Means
Bowman	small	3.5	3.2	5.0	3.9
	medium	4.9	3.6	3.8	4.1
	large	5.4	4.3	3.6	4.4
	Means	4.6	3.7	4.1	4.1
Currin	small	6.0	6.3	7.4	6.6
	medium	7.1	4.7	5.4	5.7
	large	7.2	8.5	6.5	7.4
	Means	6.8	6.5	6.4	6.6
Smith	small	4.4	2.2	5.3	4.0
	medium	5.6	5.0	6.0	5.5
	large	5.5	5.3	5.7	5.5
	Means	5.2	4.2	5.7	5.0

DISCUSSION

Main Study

Direct seeding was quite successful on all four tracts. Protecting the nuts from squirrel pilferage was of no benefit on these four widely scattered tracts. However, in other years and in different places squirrels could be a serious problem. March sowing with stratified nuts was better than November sowing with non-stratified nuts on all four tracts. Again, however, a different year might give different results. Results were still good even with November sowing, and if nuts can be easily obtained it may not make much difference when they are sown. Squirrels seem to be attracted to freshly disturbed soil. If squirrels are a problem, seeding in the fall when food is plentiful may result in less pilferage than seeding in the spring when food is scarce.

[1/] No analyses of variance were made due to missing data. Only 8 nut treatment rows were sown in each replication, and 11 of the 12 replications had treatment rows with no seedlings. The means in Table 9 are weighted means, i.e. the average height of all seedlings on all 4 replications.

We found that we could delay thinning at least seven years in order to pick the best crop trees and minimize corrective pruning. This also allowed time for fast and slow starters to show what their long-term growth potential might be.

After seven seasons, direct seeded seedlings were almost as tall as planted seedlings and were growing at about the same rate.

It would be easier and quicker to seed in plowed furrows placing the nuts about six inches apart than to sow as we did. Another advantage of seeding in furrows is that it would be easier to apply herbicide, select crop trees, and do corrective pruning. Furrows could perhaps be 15 or 20 feet apart.

Supplemental Study

Small walnuts did not produce nearly as many seedlings as medium and large walnuts, but this may not be a big consideration if nuts can be easily obtained. Sizing the nuts as we did in this study takes considerable time, and we doubt that it could be justified. However, a landowner collecting his own nuts could avoid trees with small nuts.

Shallow planting was better than deep planting, but if squirrels are a problem, the deeper planting may provide some protection. Again, if nuts are easy to obtain and squirrels may be a problem, the deep planting may be preferable. This study indicates that an adequate stand can be obtained with a 7 inch sowing depth if enough nuts are sown. The deeper sowing does not seem to have any long-term harmful effects on height growth, as after 5 seasons, seedlings from nuts sown at 7 inches were about as tall as seedlings from nuts sown at 3 inches.